LICHENOPORA HOLDSWORTHII, *Busk*. (Pl. XV. figs. 7 & 8.)

Discoporella Holdsworthii, *Busk, Cat. Mar. Polyzoa*, pt. iii. p. 33, pl. xxx. fig. 4.

Lichenopora Holdsworthii, *Waters, Quart. Journ. Geol. Soc.* vol. xliii. p. 347; *Ann. Mag. Nat. Hist.* ser. 5, vol. xx. p. 261.

I have already (Quart. Journ. Geol. Soc. xliii. p. 347, and elsewhere) alluded to the "rays" in the zoœcial tubes and cancelli, and to Mr. Busk perhaps referring to these when he speaks of stellate pores

The ovicell occurs as a central inflation with large roundish depressions closed with a perforated pellicle. It spreads in between the radii in somewhat the same manner as in *L. californica* though not so marked on the surface. I have only seen the one ovicell; and if this was the only specimen of *L. Holdsworthii* known, I doubt if it would be possible without breaking up the specimen to decide whether there was an ovicell.

Loc. Living: Ceylon; Victoria; 'Challenger' station 142 (S. Africa). Fossil: Waipukurau (New Zealand).

EXPLANATION OF PLATE XV.

Fig. 1. *Lichenopora californica*, Busk. Showing ovicell extending between the radii. From Port Western (Victoria). × 12.

2. Cancellus of *L. echinata* showing denticles. × 85.

3. *Lichenopora echinata*, MacG. Shows to the left the lower surface of the ovicell formed by reticulated cells covered with a pellicle. The upper surface is pitted. × 25.

4. *Lichenopora victoriensis*. Shows ovicell and two ovicellular ducts. From Port Stephens, 5–6 fath. (New South Wales). × 25.

5. *Discotubigera lineata*, MacG. Shows the ovicell at the border of the colony, and also the ovicellular duct. From Port Jackson (New South Wales). × 25.

6. *Lichenopora echinata*. Shows the formation of the ovicell which starts from several points to meet over the centre. From Port Phillip. × 12.

7. Cancellus of *L. Holdsworthii*, showing rays. × 85.

8. *Lichenopora Holdsworthii*, B., with ovicell. From Port Phillip. × 25.

Researches into the Life-histories of *Glyciphagus domesticus* and *G. spinipes*. By A. D. MICHAEL, F.L.S., F.Z.S., F.R.M.S.

[Read 3rd May, 1888.]

(PLATE XVI.)

FOR over three years last passed I have been, as opportunity offered, endeavouring to elucidate certain obscure points which I had observed in the post-embryonic development of the common

Glyciphagi, the specific names of which are mentioned in the title of this paper; it is the progress and results of those investigations which I now propose to record.

The inquiry has involved a considerable amount of care and labour, not only from the inherent difficulties of isolating, rearing, and watching these minute creatures, but also because it has necessitated very numerous dissections of soft hyaline *Acari*, some of them less than the fifth of a millimetre in total length, and of the cast skins of these organisms.

Glyciphagus is a genus of atracheate *Acari*, belonging to the family Tyroglyphidæ, but which is distinguished from the genus *Tyroglyphus*, or cheese-mites, by, *inter alia*, the rough cuticle, covered with granulations or vermiform markings, the pectinated or plumose hairs and long, slender tarsi of *Glyciphagi*, as *opposed* to the polished cuticle, setiform hairs, and usually shorter tarsi of *Tyroglyphi*, and more especially by the females of *Glyciphagus* possessing a central tubular projection from the posterior margin which is absent from those of *Tyroglyphus*: some years ago I showed this to be a bursa copulatrix, a fact which, I believe, is now generally admitted; the bursa doubtless exists in *Tyroglyphus*, as indeed Dr. Nalepa has proved in one species, but it does not form an exterior projection.

In order that this paper may be understood it is necessary to state, as shortly as possible, what a *Hypopus* is; but as, in a former paper read before this Society*, I entered fully into the question, I do not propose to detail the various opinions held by different authors on the subject, nor the investigations which led me to the results given, except so far as is absolutely requisite in order that this paper may be intelligible; I shall simply state conclusions, referring to that paper for all proofs and other information on the subject. *Hypopi* are minute *Acari* provided with a smooth, chitinous carapace, which conceals the whole, or almost the whole, of the creature; they are somewhat arched on the back, but still considerably compressed dorso-ventrally; the mouth-organs are rudimentary and the posterior pair of legs are terminated by hairs, not claws. *Hypopi* are most commonly found adhering to insects, miriapods, &c., and they have been ultimately shown to be a stage in the life-history of some *Acari* of the genus *Tyroglyphus* and one or two allied genera, although they are very unlike all other stages of *Tyroglyphi* in appearance. The stage does not occur in the life-history of every individual of a species, but in a comparatively limited number of instances. Mégnin considered that the stage occurred when, from drought or unfavourable circumstances, the colony was in danger of perishing, and that the nymphs of *Tyroglyphus* had the power of turning into *Hypopi* and so remaining until either the circumstances had again become favourable in the place where they were, or until they had emigrated into more suitable quarters—the *Hypopus* being better able to endure drought &c., and more capable of adhering to insects and thus escaping than the other stages of the creature. I think that I proved by the investigations detailed in the paper above referred to that this was an error, and that unfavourable circumstances did not affect the question—the Hypopial stage being a provision of nature to ensure the distribution of the species, occurring irrespective of adverse conditions, and that it occupied the period between two ecdyses in the life-history, commencing in the species which I was then studying at the second nymphal ecdysis.

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* "The *Hypopus* question," Journ. Linn. Soc., Zool. vol. xvii. (1884) pp. 371–394.

Glyciphagus is not one of the genera in which a Hypopial stage has ever hitherto been found to exist, except in the case of *G. Crameri* described by me in 1886 *; and this, as pointed out in the paper in which I described it, is an extreme species of the genus, which would hardly be included in the genus were it not for the connecting-links, and would undoubtedly fall within Haller's genus "*Dermacarus*" if that genus were retained. Of the two species named in the title, one, *G. spinipes,* was first recorded by Koch; and, so far as we know at present, there is not any difficulty in identifying it, and but little synonymy connected with it. *G. domesticus* can, however, hardly be said to be in this happy position: the synonymy of this species would probably be voluminous; but this is not the place to investigate it, beyond what is necessary for identifying the species that I have been experimenting upon. The species was originated by de Geer, who called it *Acarus domesticus,* the division of *Tyroglyphus* from *Glyciphagus* not having been effected at that time; one result of this has been that numerous writers have identified the creature with the common cheese-mite (*Tyroglyphus siro,* Linn.). Now, however, that the distinction between the two genera is understood, it is abundantly clear that de Geer's species was a *Glyciphagus*;

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* "Upon the Life-history of an *Acarus,* one stage whereof is known as *Labidophorus talpæ,* Kramer, &c.," Journ. R. Mic. Soc. 1886, pp. 377–390.

it appeared in 1778. In 1841 Gervais published a very short description and very imperfect drawing of a species which he called *Glyciphagus cursor.* In 1867 Robin and Fumose published a very carefully prepared article in Robin's 'Journal de l'Anatomie et de la Physiologie,' in which they, probably correctly, identified de Geer's and Gervais's species; but, for some reason which is not quite apparent, they retained Gervais's name, not de Geer's. M. Mégnin, in the observations mentioned below as having been made by him, has followed Robin and Fumose in calling the species *G. cursor*: unfortunately neither of these able authors gives a figure of their *G. cursor*; had Robin and Fumose added such a drawing as they furnish of *G. spinipes* no doubt could arise as to what their species is. A good figure of what is apparently the male of *G. domesticus* is given by Berlese (Acari Ital. fasc. xiv. no. 3); it is accompanied by a short description, which, however, is supplemented by the notes to the same work (fasc. i. pp. 9, 10). This author, however, does not say whether he considers it to be identical with *G. cursor*, and the points which he gives for identifying his species do not admit of comparison with those given by Robin and Fumose for *G. cursor.* I imagine the two species to be identical. Under these circumstances I have thought it best to give a figure of the female of the species I have been dealing with, to facilitate identification; it is, I think, the *G. domesticus* of de Geer and Berlese, and, so far as I can judge at present, it is also the *G. cursor* of the other authors above named.

It would be out of place here to give any formal description of such well-known creatures; but as these two species, *G. spinipes* and *G. domesticus*, are commonly found together, and are not easily distinguished at first, although a little practice enables the student to do so with facility and certainty, it may be useful to state some of the principal characters by which they may be distinguished; these are:—Firstly, that the tarsi of *G. spinipes* are thickly clothed with very fine short hairs (Pl. XVI. fig. 12), but do not bear any hairs much longer than the general average; the tarsi of *G. domesticus* are smooth, but have a few straight hairs or spines much longer than those of *G. spinipes* (fig. 5). The hairs on the tarsi of *G. spinipes* are best seen in dry specimens using an amplification of from 150 to 200 diameters; they are not so easily seen with lower powers nor in specimens mounted in balsam, or even in fluid. Secondly, the tarsi of *G. domesticus* are considerably longer than those of *G. spinipes*. Thirdly, *G. spinipes* has an obtusely conical shape anteriorly, and is suddenly contracted between the second and third pair of legs; *G. domesticus* has this form indicated but very slightly, being nearly as wide posteriorly as in the middle of the body; the difference can only be well seen in living specimens. Fourthly, the bursa copulatrix of the female projects considerably more in *G. domesticus* (fig. 7) than in *G. spinipes* (fig. 15). Fifthly, *G. domesticus* is a trifle the larger, but this cannot be relied upon. Sixthly, the hairs of *G. spinipes* are more deeply serrated and stronger than those of *G. domesticus*. Seventhly, the tibiæ of the first and second pairs of legs in *G. spinipes* each bear two large and thick curved, strongly-serrated hairs; these are much less developed in *G. domesticus*. Eighthly, the second joints of the third pair of legs in *G. spinipes* each bear on the outside a peculiar hair or scale (fig. 14), shaped like a husk of corn, and placed with the concavity inward; its outer surface is thickly clothed with fine hairs or processes: this structure is most developed in the female; it has not, I think, been mentioned by previous writers; it is not found in *G. domesticus*. Ninthly, *G. spinipes* when placed on its back, or otherwise disturbed, has a rapid struggling or fighting motion with its first and second pairs of legs, a little of which is seen in its ordinary walk; this style of movement is very characteristic of the species.

The Tyroglyphidæ, like most of the other *Acari*, have an inert period previous to each ecdysis; during this time the creature is motionless and apparently dead, except that it does not shrivel up; it is needless to say that a proper examination will disclose that the development of the creature in its next stage is progressing inside the dead cuticle.

GLYCIPHAGUS DOMESTICUS.

During the month of May, 1885, when I was examining some material which had been sent to me and which was swarming with *G. domesticus* in various stages, I observed that there were some which could only be classed as inert nymphs, but which had not quite the ordinary appearance of the creature in that stage; the cuticle was more opaque, and seemed thicker and whiter, the back was more arched, the empty skin of the legs was more apt to be rubbed off, as if the inert stage had lasted longer than usual, giving a case-like appearance; and I propose in this paper to use the expression "cases" to signify this phase in the life-history; it must, however, be understood that each case is only a nymphal skin, but it is a nymphal skin under special conditions. The finely granular marking or wrinkling of the cuticle of the species was very apparent, and when a portion was examined with a sufficient power this was resolved into the labyrinthine and vermiform wrinkling of which an illustration is given (Pl. XVI. fig. 3). It was also noticeable that the contents of each case were more drawn toward the anterior end than is usual in the nymph during ecdysis. Of course the first step was to ascertain that these cases were not simply dead creatures; for this purpose, in the latter part of May 1885 I isolated three in a separate glass cell, placing them under what experience had taught me would probably be favourable conditions of existence. On the 10th June, 1885, three immature *Glyciphagus domesticus* emerged from these cases. The cases did not split irregularly like an ordinary nymphal skin, but opened by the posterior end of the case, which had been concave, being pushed out so as to become rather convex, and separating from the lateral and ventral portions of the case, while it remained attached to the dorsal; thus when the creature within had escaped, the posterior end formed a sort of lid attached to the dorsal surface (fig. 4). This I subsequently found was the usual, although not the absolutely invariable, mode of opening. I did not then examine the precise stage that the creatures were in, but I noticed that the cases, although open, did not appear to be entirely empty (I subsequently found that what they contained was a cast skin).

On the 10th June, 1885, I placed thirteen more cases in a second cell, and submitted them, as I had hoped, to conditions similar to the first; but either from some defect in the arrangement of the cell, or from unfavourable weather, these specimens gradually died, so that toward the end of July there were not any alive. On the 30th July, 1885, I again isolated several cases in a separate cell. In a week I found that two of them were open at the posterior end and that there were two nymphs of *Glyciphagus domesticus* in the cell; more subsequently emerged from the other cases. I again observed that the cases from which they had come did not appear to be absolutely empty. I now took three of the nymphs which had emerged from the cases and placed them in a separate cell; in about a week they had all become inert; a few days later an adult female of *G. domesticus* escaped out of the cuticle of one of these inert nymphs, the others soon followed. The cast skin from which the adult emerged was thin and fine, very different in appearance from that of the cases. One point at least had now been established, viz. that the cases were a penultimate nymphal stage—*i. e.* that the nymph which emerged from the case became adult at its first ecdysis.

While these observations were in progress I also endeavoured to obtain a knowledge of the matter by dissecting the cases and their contents; but as, in order to avoid any chance of error, I have lately repeated these dissections on a large number of specimens, I will describe the results of both together in order to avoid repetition.

At this time I was forced by other engagements to abandon the investigation temporarily; and I did not make any further observations on the same species until the present year (1888). On January 25, 1888, I placed in a cell four cases taken from fresh material which I had obtained, but which contained very few cases, some of which I reserved for dissection; but in spite of my providing them with gentle warmth and slight moisture, such as would apparently form the most favourable conditions, these cases still (May 3) remain in the same condition as when placed in the cell*. On April 9, having found that a great many cases had now formed in the same material from which the last had been taken, I placed a number of these in three separate cells. On 21st April I found an inert nymph of *G. domesticus* in one of these cells which had escaped from a case, and must have emerged and become inert since the cell had been last examined, which happened to be two days; longer than usual. On the 26th April the adult emerged, and a second nymph had emerged and become inert prior to the final ecdysis. On the 1st May an adult female of *G. domesticus* emerged from this last-named nymph. I carefully examined it and made certain of the species.

Between the commencement of January and the end of April 1888, I dissected a large number of these cases of *G. domesticus*; the results were entirely confirmatory of those which I had obtained in 1885—viz., that inside each full case, and almost filling up the anterior portion of it, but not the legs, which were empty, was a protoplasmic mass which had a transparent, colourless, and almost structureless cuticle. This mass had a rounded

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* They subsequently emerged on 15th July.

posterior and a pointed anterior end; was compressed dorso-ventrally, particularly at the posterior margin; and had a more or less plain sulcation round it, as though dividing cephalothorax from abdomen (in some specimens this was very marked). The mass had the general form of a *Hypopus*, but there was not, in any instance, any trace of legs, mouth, or other external organs. In many instances the protoplasm appeared to be divided into large cells, like an egg in an early stage of segmentation; in others the cell-division appeared to have gone further, the cells being much smaller and finer, particularly in the posterior portion of the creature, but some of the larger cells remaining; in others, presumably more advanced, the finer granulation was more uniform. The mass was always motionless, but in one instance I did find a living nymph within the case instead of the inert mass; this of course was ready to emerge. The cases from which the occupant had emerged almost invariably contained the cast cuticle of the protoplasmic mass, which cuticle did not show a trace of legs, mouth, or any other organs.

GLYCIPHAGUS SPINIPES.

At the end of 1885 I was at a farm-house for a short time, and thought it a favourable opportunity to renew the investigation. I found in the chaff-house, in the dust and chaff, and also attached to the walls and beams, a number of cases which I at first supposed to be similar to those I had before dealt with: I soon, however, found that these were even more opaque than the former specimens, and that they were coarsely reticulated instead of being finely vermiform in markings; the empty cases also opened differently, the posterior cuticle breaking away from the dorsal and lateral, and remaining attached to the ventral, so that the posterior end opened downward instead of upward, and was more torn; the hinder part of the dorsal cuticle also was usually split along the median line and the two sides somewhat separated. It was therefore probable either that they were in a different stage from those observed in June and July of the same year, or that they were under different climatic or other conditions, or that they belonged to a different species of *Acarus*. I finally found that the last explanation was correct, and that these reticulated cases were those of *G. spinipes*. Between the 28th December, 1885, and the 1st January, 1886, I found a considerable number of these cases. I placed some of them in a cell as before and dissected others; these, in many instances, contained not the inert legless mass found in the cases of *G. domesticus*, but a distinctly formed living *Hypopus*, which had not assumed the usual brown chitinous colour, and could not be called active, but still was fully formed, and provided with short and stumpy, but thoroughly-developed legs, which it could move about, although only in a feeble manner; it was not capable of walking (ordinary *Hypopi* are very active), and it was evidently not in a condition fitted for existence as a free-living creature; but yet it was undoubtedly alive and fully formed; its total length was about ·19 millim., its greatest width about ·15 millim. Each tarsus of the first three pairs had an exceedingly long, very slightly curved, blunt claw; the tarsi of the fourth pair were devoid of claws and hairs. A figure of this *Hypopus*, carefully drawn from a specimen dissected out of a case in January 1888, is given in Pl. XVI. fig. 9. The majority of the *Hypopi* dissected out of the cases were not capable of any movement; it was only a few which were able to move their legs. I now searched the chaff and material, and the dust &c. swept from the walls and beams of the chaff-house, very carefully in hopes of finding active *Hypopi* which had emerged and were capable of walking about, but neither on this nor on any other occasion have I been able to discover anything of the kind; but I did find one or two inactive *Hypopi* not capable of any movement, which seemed as if, from some accident, the cases had been broken away from them. On 2nd January, 1886, I took one of these, and one of the *Hypopi* dissected out of a case and which could move its legs, and put them in a cell by themselves. I watched them at frequent intervals, but they did not die or shrivel up. On the 15th January I missed one of the *Hypopi*; but close to where it ought to have been I saw a nymph of *Glyciphagus spinipes*, which had evidently just emerged and had some thin membrane attached to it; on detaching this membrane, and examining it with a higher power, I found that it was the cast skin of the *Hypopus*. I put both the nymph and the cast skin in glycerine for permanent preservation. A few days later I dissected four more of the cases and took out four *Hypopi* and placed them on a small piece of dried leaf in a separate cell; the next day I found that two had collapsed, probably having been injured during the dissection of their cases. The following day I observed that one of the remaining two had moved, and on touching it with a fine hair I saw that it was alive and able to move about very slowly; but the day after it had collapsed and was dead. There was now only one *Hypopus* left; this did not move nor show any sign of life; but, on the other hand, it did not collapse, and in this condition it remained for nearly four months. I watched it every day without seeing any change until the 24th May, 1886, on which day a healthy nymph of *G. spinipes* emerged from the Hypopial skin.

While this experiment was progressing I had also watched the cell in which I had placed the cases: one nymph of *G. spinipes* had appeared in the cell and one case was open at the posterior end; otherwise there was not any change. But on the 26th May I found two more cases open and two *Hypopi* had apparently crawled out of them; on touching these *Hypopi* they appeared inert and incapable of motion, but a few days after nymphs of *G. spinipes* emerged from them.

In October 1887 I again obtained more material from the same chaff-house, and also from another farm some fifty miles distant from the first; this latter contained *G. domesticus*. In both samples the *Glyciphagi* were numerous and the larvæ and nymphs were abundant, but I could not find any cases or any trace of *Hypopi* in either.

In January 1888 I once more took up the investigation: I obtained material and sweepings from the same chaff-house and again found the reticulated cases of *G. spinipes*; most of them were open at the posterior end, the occupants having emerged. I put seven of the full cases in a separate cell; in one of these cases I could easily distinguish a *Hypopus* moving its legs. I also found one which had apparently come out of the case, and which was capable of the same amount of motion; it was from this specimen that fig. 9 was drawn. On February 6 I found that one of the seven cases was open and that a nymph had emerged from it. I isolated this in another cell, which I will call cell 5. On February 8 another nymph emerged from a second of the seven cases. I placed this nymph also in cell 5. On February 9 an adult *G. spinipes* emerged from one of the nymphs in cell 5, the second nymph also was inert. On February 26 an adult of the same species emerged from the remaining inert nymph.

From this time up to the end of April, when I closed the observations, nymphs of *G. spinipes* continued to emerge at intervals from the remainder of the seven cases, and from other cases which I had put in different cells, and adults continued to emerge from the nymphs, so that there could not be any doubt of the species, or of the process being a regular one.

I also in January 1888, and again in April of the same year, dissected numerous reticulated cases from which the nymph had emerged; in almost every instance I found within the case an unmistakable cast Hypopial skin having perfectly distinct legs.

Concurrent investigations by M. Mégnin.

It appears that while I was engaged on these observations M. Mégnin was also investigating some points relative to the *Glyciphagi*, and, *inter alia*, almost the same subject as my own *. We did not either of us know of the other being so occupied. Mégnin approached the matter from a standpoint different from mine: he did not find an object which excited his curiosity to discover its cause; but it struck him that as *Tyroglyphus* has a Hypopial stage, so closely allied a genus as *Glyciphagus* ought also to have it, and he deliberately set himself to search for that stage; but he tells us that he searched in vain; he tells us, however, that he discovered an equally curious phenomenon, which he says shows how prodigal nature is in processes for preserving the lower creatures. He, believing that the change of a nymph of *Tyroglyphus* into a *Hypopus* is caused by unfavourable surroundings, states that under similar conditions he found that those of *Glyciphagus* became inert, that a liquefication of all the organs took place " as in a change of skin," and that the gelatinous substance collects in the cavity of the " thorax " in the form of a spherical mass surrounded by a chitinous envelope and thus forming a cyst very similar to those formed by some Infusoria previous to the drying up of the water in which they are contained. Mégnin suggests that in this condition the dried nymphal skins containing the cysts would be blown about by the wind and would thus finally arrive at some place where the conditions would be favourable and would then emerge, and that the species would be thus distributed.

Mégnin says that his species were *G. spinipes* and *G. cursor*, which latter is, as before stated, presumably the same as *G. domesticus*; but he does not distinguish between the life-histories of the two, nor identify any particular observations with either species.

I do not intend here to discuss the vexed question of whether the liquefication of the organs of an *Acarus* during ecdysis is complete, involving a return of all the organs to an egg-like state, or whether it is only partial: the former has long been Mégnin's view, and he cites Claparède as confirming it; but on reference to the Swiss author's writings this does not seem to be by any means certain. Dr. Nalepa, who has lately investigated the subject with regard to the Tyroglyphidæ, is strongly of opinion that it is only partial*. I was formerly inclined to think, chiefly on Mégnin's authority, that it was complete; but more lately, having paid some personal attention to the subject, I have come to a conclusion with regard to the Oribatidæ † more in accordance with Dr. Nalepa's views. It is clear that Mégnin has been observing a process either identical with or very similar to what I have seen in *G. domesticus*, but that not having found the more fully developed *Hypopus* in *G. spinipes* he has naturally not recognized that what he found was really a rudimentary *Hypopus*—the difference of the spherical form of the inert mass found by him in his cysts from the more *Hypopus*-like form of the corresponding mass found by me in *G. domesticus* may possibly be accounted for by his specimens having been examined more shortly after the change commenced than mine were, or by his observations having been made on *G. cursor*, and that species not being really identical with *G. domesticus*, although much resembling it, but having the Hypopial stage even more rudimentary.

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* Comptes Rendus, ciii. (1886) pp. 1276–8.

It is quite possible that Mégnin's idea that the inert nymph when containing the Hypopial form, or, as he calls it, the cyst, would be blown about by the wind may be correct: I do not see that it would be more liable to be so blown about during this than during any other ecdysis, except in so far as this may last longer; but undoubtedly the creature within, protected by its Hypopial skin, would bear more exposure and rough treatment than the *Acari* would during other ecdyses. It will probably, however, be gathered from the foregoing pages that I cannot agree with Mégnin that the change to the Hypopial, or as he calls it encysted, condition is produced by desiccation or unfavourable surroundings. I have not conducted a series of experiments expressly designed to determine this exact point, as I did with the *Tyroglyphi*; but my material was not kept in any desiccated or unfavourable condition; on the contrary it was naturally kept under the most favourable conditions I could devise, and the *Glyciphagi* throve admirably; but the cases containing Mégnin's cysts were formed rapidly and numerously in it; from which, and from the general experience acquired during the somewhat lengthy observations above described, I feel assured that with the *Glyciphagi*, where the Hypopial stage is more or less rudimentary, as with the *Tyroglyphi*, where it is an active and functional one, the change to this stage is normal, although not existing in the life-history of every individual, and is not induced by desiccation or other unfavourable conditions; but, on the contrary, proceeds best and most rapidly when all conditions are favourable. I do not deny that a creature may remain longer in the Hypopial condition after it has been formed when the surroundings are more suitable to that stage than to the ordinary nymphal state, than it will when the converse is the case; I think this not improbable, although I have not seen any evidence to prove that such is the fact.

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* "Die Anatomie der Tyroglyphen," Sitzungsb. k. Akad. Wien, i. Abth. Juli-Heft, 1885, p. 151.

† "British Oribatidæ," Ray Society, vol. ii. (London, 1888), p. 604.

Conclusions.

The results of the investigations detailed above may be summarized as follows:—

1. There is a Hypopial stage in the life-history of *Glyciphagus* just as there is in that of *Tyroglyphus*.
2. That this Hypopial stage is far less developed in *Glyciphagus* than in *Tyroglyphus*, and is not, so far as is known at present, an active stage.
3. That we do not at present know whether it occurs in all species, but it certainly does not occur in the life of every individual of a species.
4. That the stage is not the result of desiccation or other unfavourable circumstances, but occurs as often under favourable conditions.
5. That the stage, in the species investigated, occupies the period between the penultimate ecdysis and that immediately previous.
6. That in *G. spinipes* the *Hypopus* is fully formed and capable of moving its legs, but not of walking or other active movement; that it never becomes hard, or of the dark colour of the ordinary chitin of active *Hypopi*. That, as a rule, it does not even leave the skin of the young nymph in which it is formed; but that the more adult nymph is formed within the *Hypopus*, and emerges

from it, while the *Hypopus* is still within the young nymphal skin; so that the *Hypopus* is not ever seen, except that, in a few instances, it may crawl just outside the young nymphal skin when the more advanced nymph is likely soon to emerge.

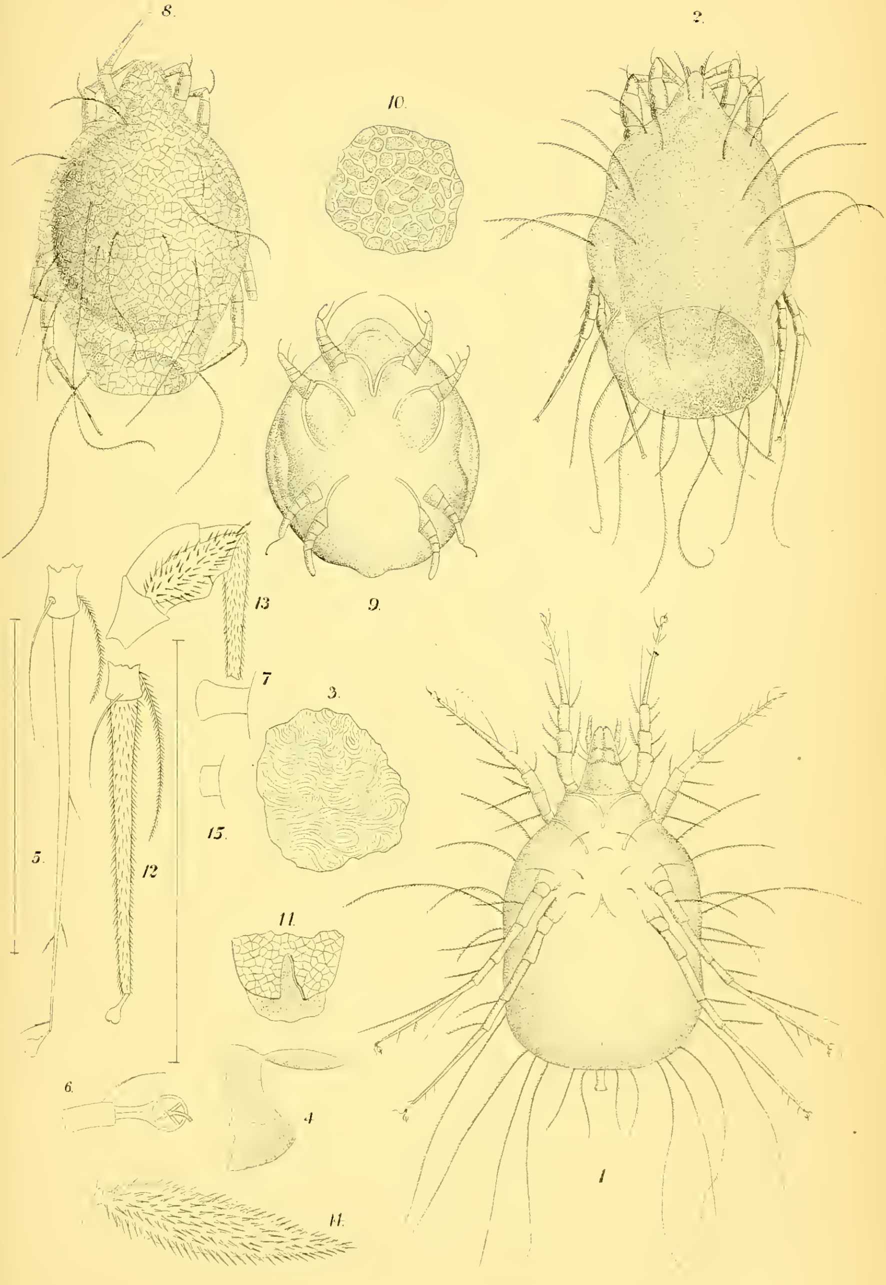
7. That in *G. domesticus* the Hypopial stage is even more rudimentary; what represents the *Hypopus* retaining only the general form of that creature, but being without legs or other external organs, and that it never emerges from the young nymphal skin.

8. That in both species the young nymphal skin within which the *Hypopus* is developed thickens and forms a "case" different in appearance from the skin during ordinary ecdysis.

EXPLANATION OF PLATE XVI.

Fig. 1. *Glyciphagus domesticus*: adult female, underside; × 95.
2. Ditto: "case" containing the inert mass (very rudimentary Hypopial condition); × 150.
3. Ditto: a portion of the cuticle of the "case," to show the vermiform markings; × 200.
4. Ditto: posterior end of "case" from which the nymph in its last stage has emerged; side view, to show the mode of opening.
5. Ditto: fourth left tarsus of adult female from above; × 200. At the side is a line showing the extreme width of the abdomen; same amplification.
6. Ditto: claw and caruncle from below, drawn from the living foot when pressed by the creature against glass; × 500.
7. Ditto: bursa copulatrix; × 200.
8. *Glyciphagus spinipes*: "case" containing the *Hypopus*; × 150.
9. Ditto: *Hypopus* dissected out of the "case"; × 180.
10. Ditto: a portion of the cuticle of the "case," to show the reticulated markings; × 200.
11. Ditto: posterior end of "case" from which the nymph in its last stage has emerged; seen from above, to show the mode of opening.
12. Ditto: fourth left tarsus of adult female from above; × 200. At the side is a line showing the extreme width of the abdomen; same amplification.
13. Ditto: part of the third left leg of adult female from the outer side; × 250.
14. Ditto: hair from the second joint of the same leg; × 500.
15. Ditto: bursa copulatrix.

A.D. Michael.



LIFE HISTORIES OF GLYCIPHAGUS DOMESTICUS AND G. SPINIPES.

A.D. Michael ad nat. del. E. Carter sc.

Mintern Bros. lith.